atom™

BLASTER

Low Racer Build Plans

Designed by Edgar Atkins

VERSION 2.3

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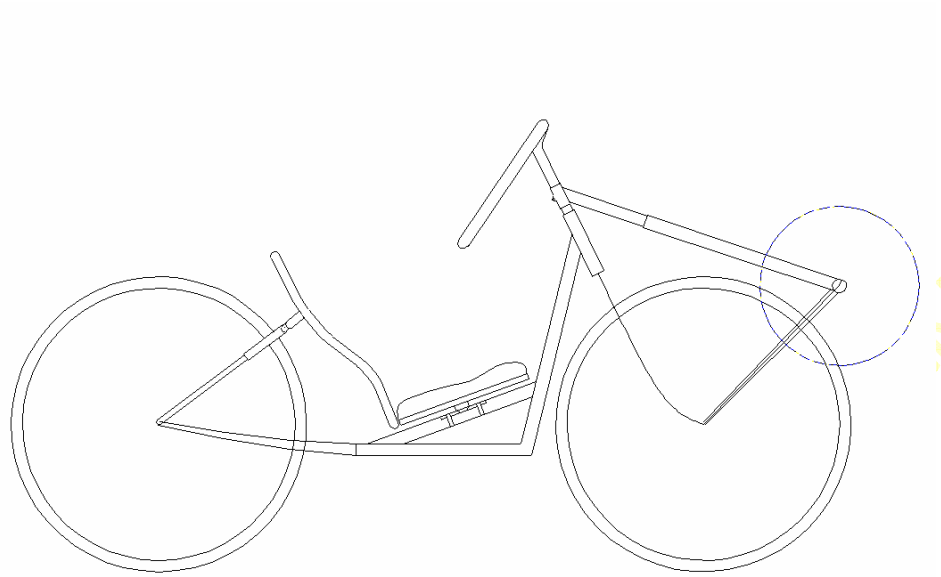

Figure 1- 26" BLASTER™

This document contains a set of drawings and work instructions that will enable you to take one (1) 26" mountain bike frame, wheels from a 20" BMX bike (or the 26" mountain bike) and a fork and tubing from a mountain or road bike (mtn forks preferred for strength) to build an atom™ BLASTER™ Front Wheel Drive (FWD) recumbent low racer. The bike may be configured as either a 20" model or 26" model using the same frame!

The design used for the drivetrain of the low racer is known as Moving Bottom Bracket (MBB), which means the entire front assembly, which is comprised of the front fork, front wheel, and crankset, moves with input from the steerer (handlebars). The advantages of this design include: less chain used (less weight and cost/better power transfer), no chain management (rollers/guides/chaintubes) issues, overall lighter weight and simpler drivetrain, easier construction, better design flexibility due to no chain constraints, stronger drivetrain subassembly, easier to jig the frame for construction, etc….

While there may be perceived drawbacks to this design, such as the rider's legs swinging from side to side, in reality, these issues are non-existent. During normal riding, the handlebars are not moved that much; the rider typically leans the bike into turns and the handlebars are relatively straight. So while it may seem this could be a problem, it is not, especially after the rider has some "seat time" on his atom™ BLASTER™. In fact, many riders claim they can ride the MBB FWD design hands off, since they can use their feet as steering inputs!

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TOOLS NEEDED FOR CONSTRUCTION

The construction of this bike is fairly straightforward, so the are no complex jigs or tools required. If you are a veteran framebuilder that understands the basics of bicycle frame construction, you may skip this section.

First and foremost, you must be able to either braze or weld both the frame and FWD assembly together. This is not a "no-weld" or bolt-together construction! Do not attempt to bond or glue this frame together.

Basically, you need to have a way to cut metal tubing, and a way to join metal tubing. The balance of the work is basic bicycle mechanic skills/tools.

Here is a list of tools that you must have to complete this frame:

- Vise
- Hacksaw or grinder with cut-off blades
- Emory paper
- Oxy-acetylene torch (or alternatively- MAPP gas torch)
- Flux and rod (if brazing)
- Files of various sizes
- ¾" emt conduit bender (for handlebars and seat)

There are other tools that would be very handy to use, such as clamps to hold tubes for brazing, but a couple of bricks on a flat concrete surface will work just as well. Another example might be a tubing cutter, which leaves a nice clean, "square" cut on the tube. But for the beginner, these tools are largely unnecessary. In addition to the above list, you will also need tools specifically for building up (and tearing down) your bicycle components. A partial list may be various allen wrenches, an adjustable Crescent wrench, a monkey wrench, a chain splitter, spanner etc…

You may choose to use a welder (arc/mig/etc) to create your frame. Keep in mind you will still need a flame source to apply heat to the front forks to remove the dropouts, and also to remove braze-ons from the frame (unless you choose to cut/grind these away).

There are many resources available (both online and in print) that detail the basics of bicycle framebuilding, and if you do not understand the basics, you should do some research and learn the basics of framebuilding before starting your frame.

The use of a jig may help final alignment; see Appendix C for some ideas regarding jig construction.

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Bicycle Terminology used in these plans

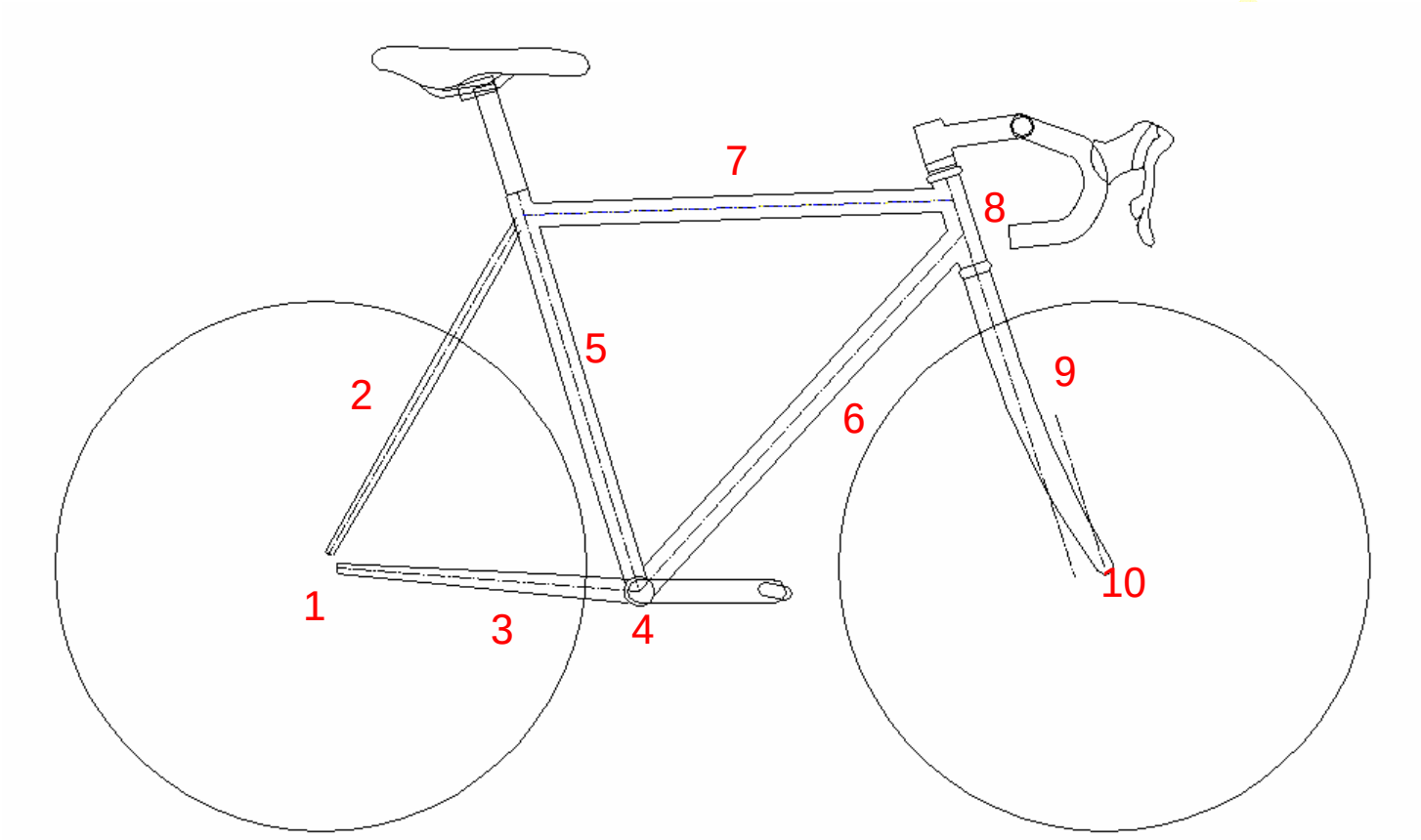

Figure 2

1. Rear Dropout(s)
2. Seat Stay(s)
3. Chain Stay(s)
4. Bottom Bracket
5. Seat Tube
6. Down Tube
7. Top Tube
8. Head Tube
9. Fork
10. Fork Dropout(s)

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Low Racer Terminology used in these plans

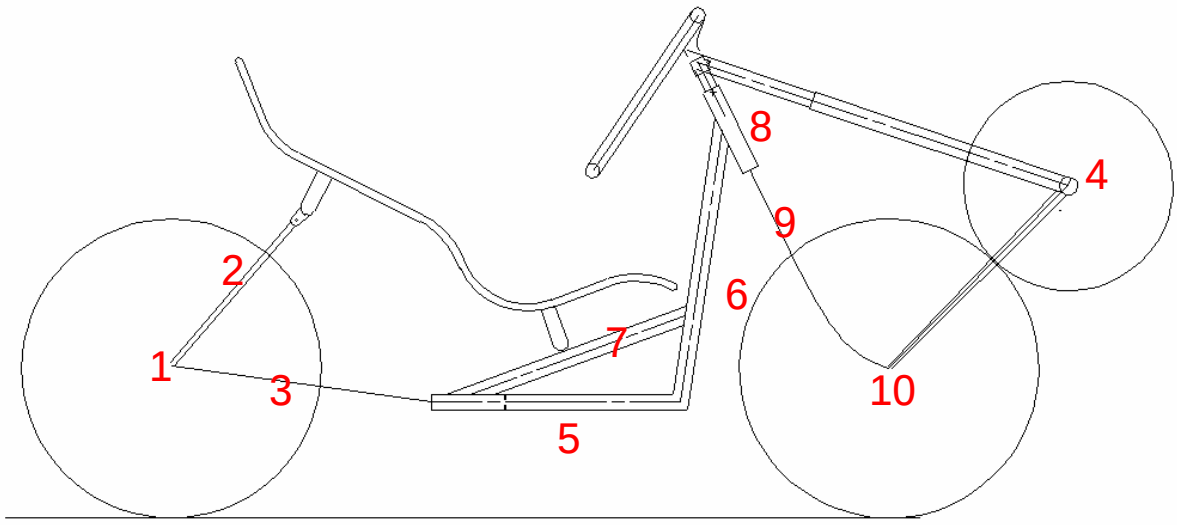

Figure 3- 20" BLASTER™

1. Rear Dropout(s)
2. Seat Stay(s)
3. Chain Stay(s)
4. Bottom Bracket
5. Seat Tube
6. Down Tube
7. Seat Tube Brace
8. Head Tube
9. Fork
10. Fork Dropout(s)

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BIKE PARTS NEEDED FOR CONSTRUCTION

OK, so now that you know what tools are needed, you have to source parts to build the bike. Here's what you will need to comply with the design and successfully complete the bike:

(1) 26" mountain bike, or alternatively, you could use a road bike frame
(1) additional front fork from a mountain or road bike
(1) additional 20" length of either 1" or 1-1/8" tubing
(2) 20" wheels (front and back) from a BMX type bike, preferably with aluminum rims, or use the 26" mountain bike wheels if you are building a 26" variant.

So, if you have an old mountain bike (with normal, round tubing; do NOT use a bike with non-standard tubing such as a "Y" frame) and several other parts, you can easily make this frame, and have some pieces left over for the next frame. The mountain bike will be used for the majority of the frame parts, as well as the powertrain components. Old mountain bikes are becoming commonplace in thrift stores (and even the landfill), and are perfectly fine for this project. Try to use a frame with vertical rear dropouts for the Front Powertrain Assembly, as this makes it easier to retain the front wheel.

One note on bike frames. Make sure that your mountain bike is NOT lugged construction, because this type of construction will make it more difficult to make some of the joints in the low racer frame. Most mountain bike frames are not lugged, which is why they are more desirable for the frame tubing.

In fact, a department store-type mountain bike may be your best source for frame tubing, because these bike frames do not use butted tubing. Butting is a process that creates a tube that is thinner at the ends or the middle (depending on specific use) by using special dies in the forming process, and is used by lightweight, high dollar bike designs to keep frame weight to a minimum. Department store bikes typically use hi-ten tubing, perfect for the beginning brazier.

As you disassemble your donor bikes, make sure you attempt to salvage all components. Do this because you will be able to use the shifters, brake levers, cables and sheaths, cable stops, derailleurs, brakes, etc. You can use WD-40 and fine steel wool to clean the parts, and actually polish away rust and corrosion.

That's it for standard bike parts. You will also need some additional materials like ¾" EMT conduit to build the handlebars and seat frame, and a 4' section of 3/8" OD aluminum tubing for the seat struts. In each section of the plans, you will see what parts of the bike to use to create the new frame.

Refer to Figures 2 & 3 for terminology use throughout these plans.

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DETERMINING YOUR BIKE SIZE

The atom™ BLASTER™ Front Wheel Drive (FWD) recumbent low racer is custom fit to your body size. The seat may be moved fore-aft on the Seat Tube Brace for adjustment, but ultimately, you will want to accurately size the frame to your size for optimum weight distribution. The seat may be adjusted approximately 8" on the Seat Tube Brace, so this is a large amount of adjustability. Just be sure not to build your frame too big, because you will not be able to comfortably reach the pedals!

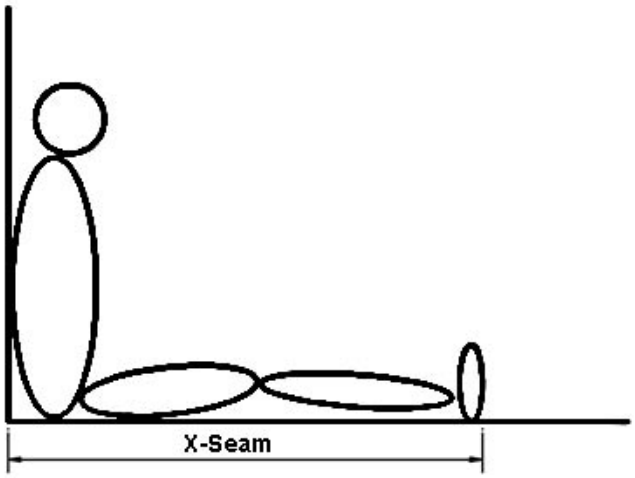

Figure 4

Figure 6 shows all the measurements need to construct the frame. Note however that these dimensions are for an approx. 5'-9" to 6'-3" person, with an X-Seam of 40" to around 46". If your X-Seam is less than 40", you should cut down the chain stays on the existing Mountain Bike frame the difference in number of inches. In other words, if you have a 37" X-Seam, then (40"-37"=3"). Cut both chainstays 3" to bring the Bottom Bracket closer to the BLASTER™ downtube. ****NOTE THAT IF YOU DO THIS, YOU WILL NOT BE ABLE TO USE A 26" WHEEL ON THE FRONT OF THE BIKE****.

To find your X-Seam dimension, use Figure 4 as a guide. Sit with your back upright against a wall, and have someone mark the location on the floor where your heel falls. The distance from the mark to the wall is your X-seam, and is helpful in custom fitting this bike to your measurements.

After finding your X-seam, measure the length of one of the crank arms you plan on using on this bike. Subtract the crank length from the X-seam length. This resultant number is the distance from the center of the Bottom Bracket to the bottom of the seat back. You may choose to layout your bike full scale on a piece of cardboard or plywood to ensure that you build your frame to the minimum size needed to ensure your legs can adequately reach the pedals, even during cornering. This can be done by measuring the rear triangle from your donor bike, and the front fork that will be used for the Powertrain Assembly (see next section) and applying these dimensions to your full-scale drawing. Figure 5 shows the X-Seam dimension overlaid on the bike frame.

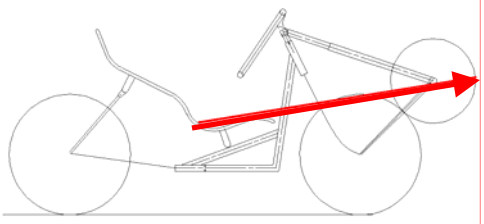

Figure 5

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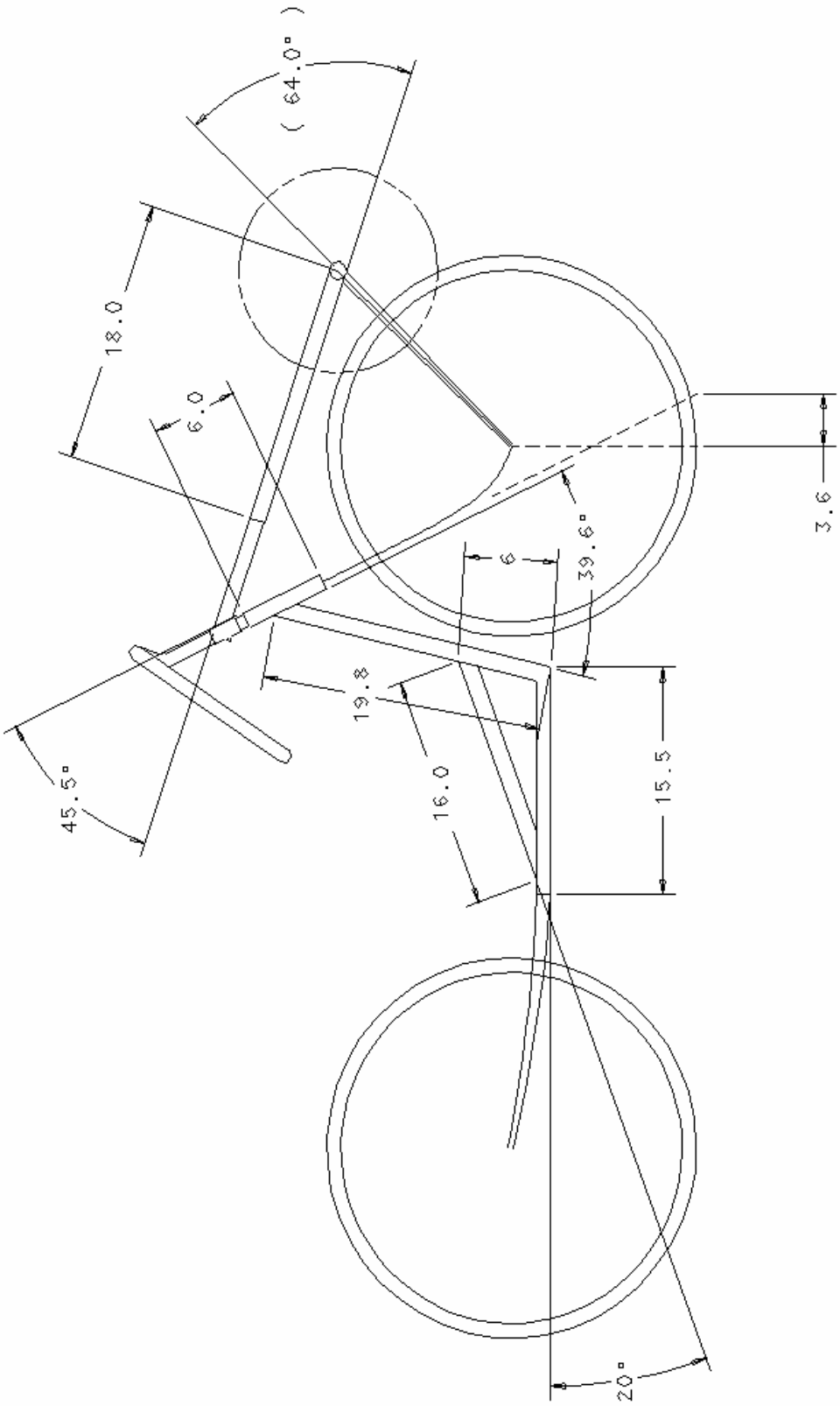

General Frame Dimensions-20” or 26” wheels

Figure 6

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FRAME GEOMETRY

The atom™ BLASTER™ can be configured with either 26” or 20” wheels. The frame geometry does not need to be altered to accomplish this. The following figures illustrate this. The Head Tube angle should be approx. 60 degrees from horizontal, which gives about 3” of positive trail for a BLASTER™ with 20” wheels; and approx. 4.7” of positive trail for the 26” version. Because of this, the 26” version will feel a little more stable at higher speeds, but the 20” version will have a quicker, sportier feel.

Figure 7

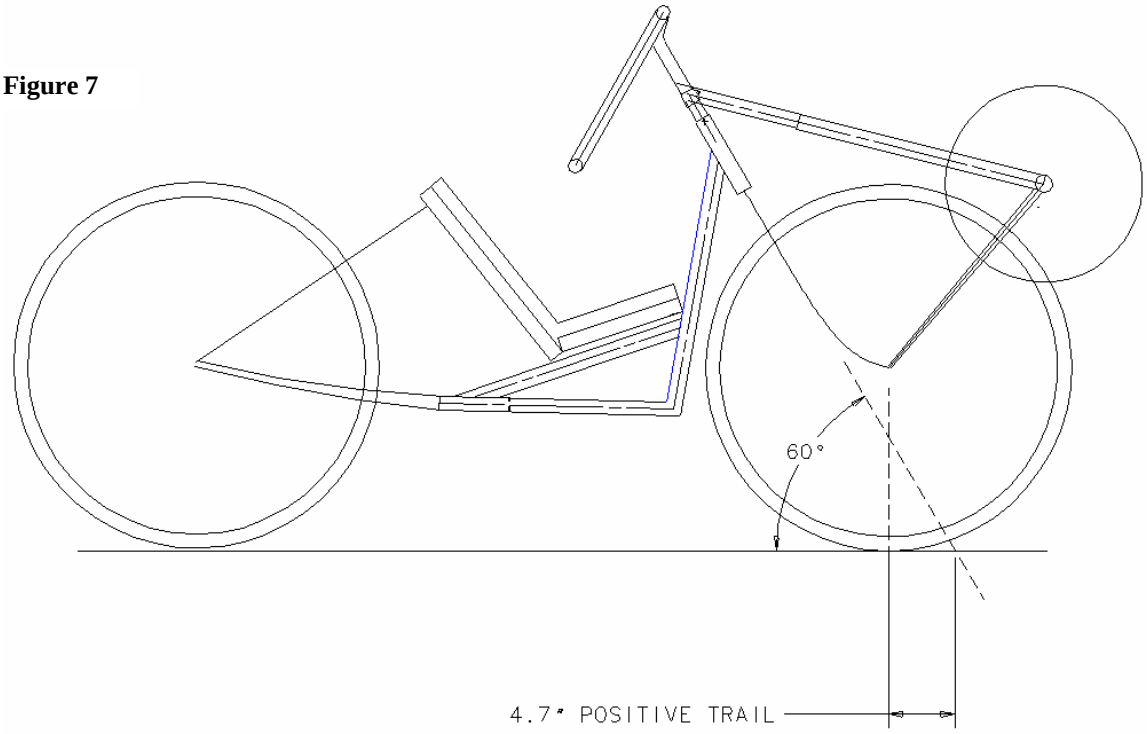
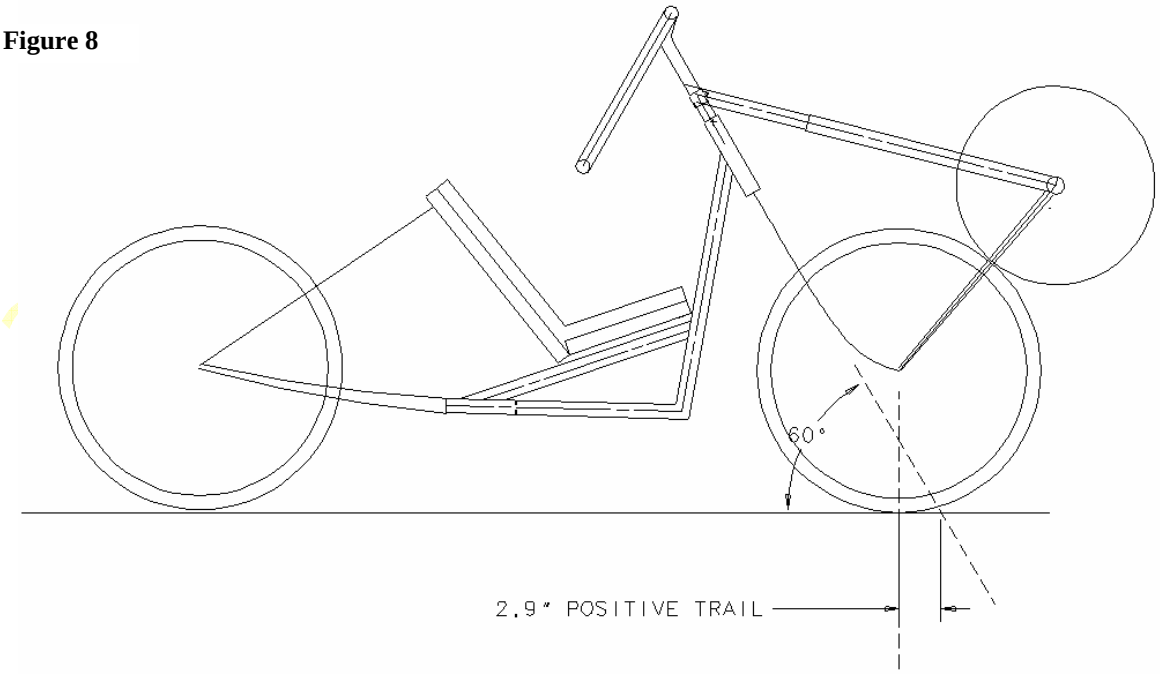


Figure 8



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FRAME GEOMETRY VARIATIONS

Since the atom™ BLASTER™ 26” and 20” versions are both based on the same frame, you can also mix and match different sizes of wheels front and rear for aesthetic, handling, and/or gearing variety. See the following figures to see what affect changing wheels sizes front and back will have on the resultant positive trail value. Also note the Headtube angle changes in both variants, which will affect handling.

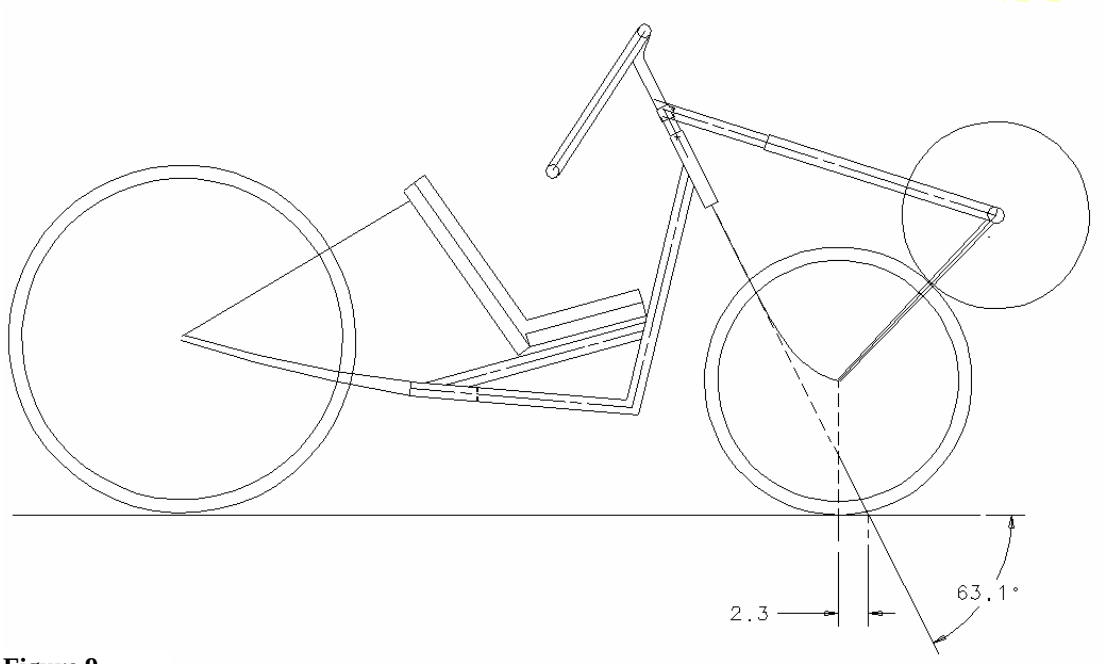

Figure 9

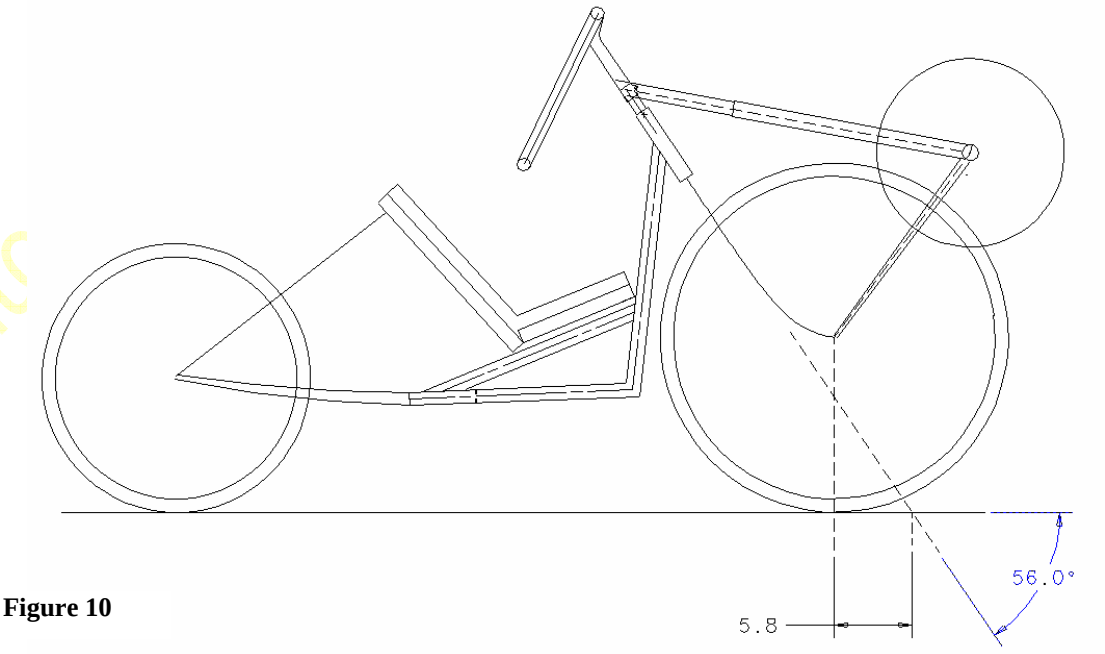

Figure 10

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JOINT PREPARATION

Introduction

This section addresses how to properly clean and prepare a joint for brazing (or welding). In order to properly braze any type of joint, the tubing must be clean in the joint area. This means removing all of the paint and oils down to bare metal. If you are sleeving a joint, the inner tube must be clean on the outside surface, but the outer tube of the sleeve joint must be clean on both the inside and outside surfaces. It is best to clean the joint a minimum 3" away from where you are going to place the brazed joint.

Removing Paint

This first step can either be difficult or easy, depending on which method you choose. It can be very time consuming and messy to sand away all the paint from a section of tubing (although it can be done). Here's an easier method. Apply a broad flame from your torch, moving it back and forth across a broad area to be stripped. A household propane torch puts out enough heat, and is a good economical choice for this. Make sure you have adequate ventilation, it's probably best that this be done outside due to the fumes this step will create. As you heat the tube, you will see the paint first turn black and bubble, then a chalky white color. When it does this, remove the heat. The paint can now practically be dusted off the tube!

Cleaning the Inside of a Tube

It is very difficult to get the inside of a tube clean. The best way to do this is to immerse the end of the tube (after removing the paint per the previous step) into Sno Bowl toilet cleaner or muriatic acid. This method is also good for removing galvanizing from a piece of EMT that you might want to braze or weld. Check the tube periodically by removing from the cleaner and inspecting. Do this step in an area with REALLY good ventilation, the fumes are nasty! This step will remove all rust and oils from the tube.

Final Cleaning

After removing all the paint and cleaning the tube with acid, rinse the tube with clean water and dry/wipe down with a clean dry cloth. After the tube has dried, use a piece of emory cloth to sand the joint area until it is shiny. Wipe down with a clean dry cloth.

The tube is now prepared for joining.

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PART ONE-FRAME

Construction- Front Powertrain Assembly

Figure 11

Step 1.

The front powertrain assembly is essentially the rear triangle of the old mountain or road bike, with the seat stays removed, brazed to a fork from a road or mountain bike. To begin this assembly, take the fork and remove the dropouts by heating and pulling the dropouts out of the forks. Be patient, the fork must be heated slowly to allow the metal to rise to the appropriate temperature. This allows the brazing filler that was initially used in the fork to melt, enabling you to remove the dropout. Ensure that the fork you are using has brazed lugs! It would be impossible to un-braze a welded joint! Do this by sanding to bare metal in the joint area- if you see bronze, it's brazed.

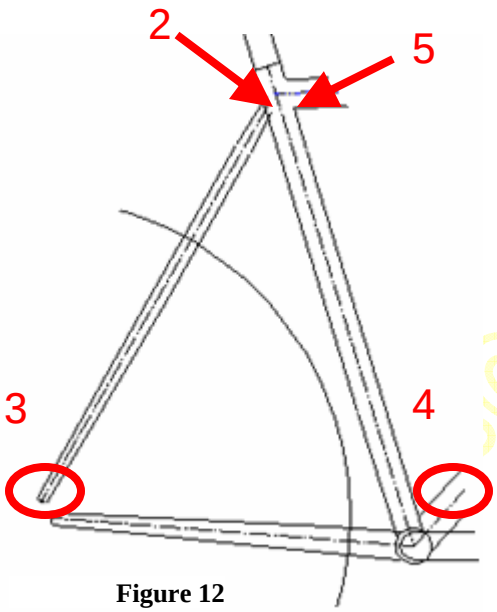

Figure 12

Step 2.

Next, cut or un-braze the joint where the seat stays meet the seat tube on your donor mountain bike. You may have no choice but to cut these joints if they are welded. Ultimately, you want to leave this joint totally flush with the seat tube, i.e. leave no trace of the seat stays.

Step 3.

Unbraze the joint where the seat stays meet the rear dropouts. Even if your donor bike is welded construction, hopefully they brazed on the rear dropouts. If the dropouts are welded on, then cut the seat stays off, leaving a ½" stub on the dropout. Shape this dropout using a grinder/file into a shape that will fit into the bottom of the front forks. The dropout should already have the properly formed tab to fit into the front fork recess; so perhaps you may just have to grind off the excess seat stay material to expose the tab on the dropout. **Make sure you do not cut the dropout from the chain stays!**

Step 4 & 5.

Cut off the Down Tube (# 4) leaving a short stub of down tube approximately 2 inches long. You can cut this tube flush to the Bottom Bracket, but it is difficult to seal the Bottom Bracket. Finally, cut the Top Tube flush with the Seat Tube, and then grind/file the Seat Tube flush (location #5).

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Step 6

At this point, you should have something that looks like figure 13 (this figure does not show the rear dropouts, which SHOULD BE ATTACHED to the chain stays). We will now attach the front fork to the rear dropouts, but to do so, the front fork must be spread. Take the rear triangle assembly that you just prepared, and set it flat on the workbench as shown in figure 14. Take the front forks, and insert the tabs on the rear dropout into the crevices at the bottom of the front forks which were created when the front fork dropouts were removed. Notice that the forks need to be spread in order to allow both sides to fit. To spread the front forks, you may either use a ¾" conduit bender or simply brute force in a vice (or use a scissor jack). Do not overbend the forks, as this causes additional stress on the crown of the forks (the part at the top of the forks below the tube the slides into the Head Tube). Once you have bent the front forks to slide onto the tabs on the rear dropouts (and have insured that the forks are spread evenly left/right), then you are ready for the next step.

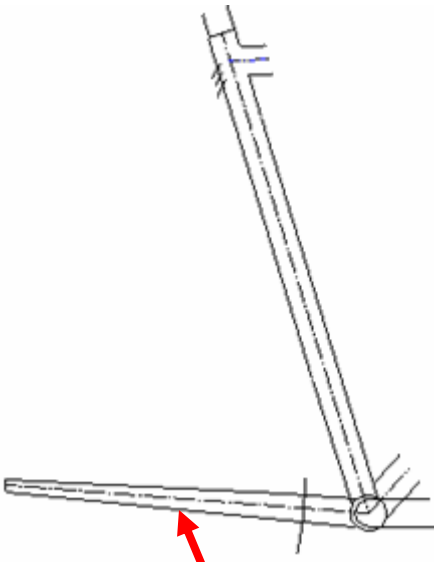

Figure 13

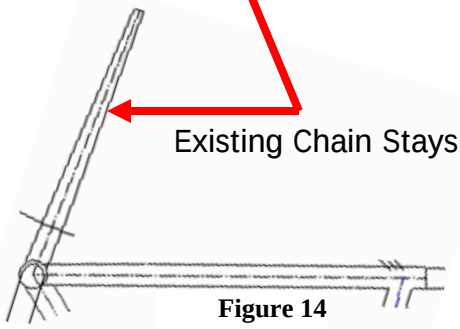

Figure 14

Step 7

With the rear triangle laying flat on the workbench as shown in figure 15, take the now-widened front forks and insert them onto the tops of the rear dropouts. You may have to support the rear triangle if you left a stub portion of the Down Tube (Step 4). You must now make a simple jig to hold the forks in the position shown in figure 15 for brazing. The easiest way to do this is to support the bottom-most part of the forks with a piece of wood cut to the appropriate thickness to allow the angle shown between the chainstays and forks. The thickness of the wood will vary depending on the length of the steerer tube that slides into the head tube. After jigging and assuring alignment, prep and braze both joints. The Powertrain Assembly is complete.

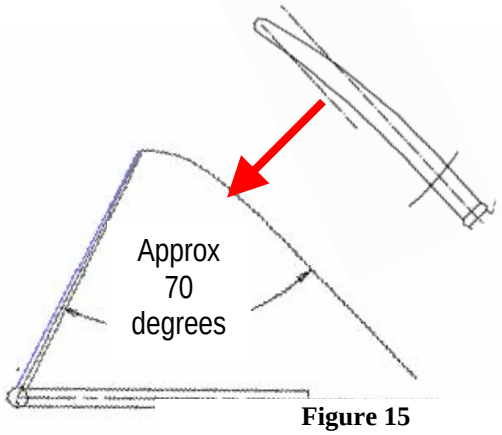

Figure 15

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Pictures- Completed Front Powertrain Assembly

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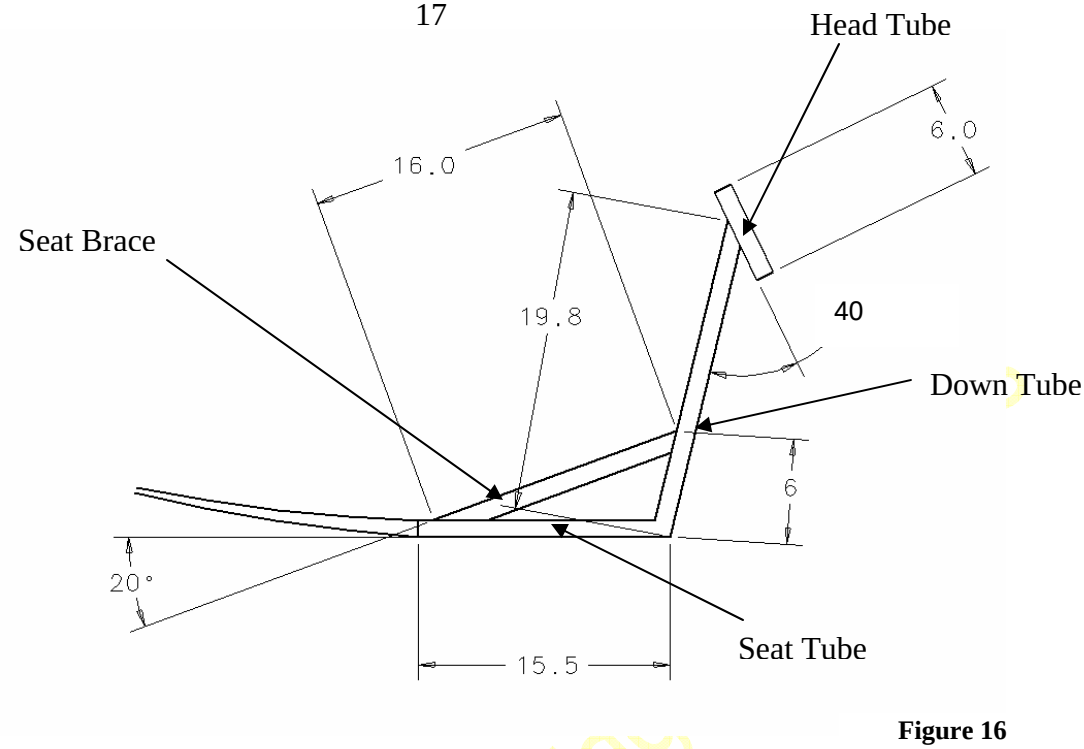

Figure 16

Construction- Main Frame Assembly

Figure 16 shows the overall dimensions for the frame. The Outside Diameter dimensions for the tubes are as follows:

Head Tube- Standard Threaded or Threadless. Usually around 1.13" OD. Recycle from donor bike but cutting top tube and down tube off flush; and grind these joints smooth, leaving just the head tube.

Down Tube- 1.25" OD (can also use larger diameter, ovalized tube from mountain bike for more strength). You could also use a larger diameter (2"OD, for instance) tube, but you must ovalize the end that joins with the head tube.

Seat Tube – 1.125/ This tube MUST be this size, because the fork used for the rear stays must slide into the Inner Diameter (ID) of this tube (unless your rear fork is 1-1/8" threadless, then use 1.25"OD tubing for the Seat Tube). Ensure that the fork used for the rear stays will slide into this tube with minimal "slop".

Seat Brace- Either 1" OD or 1.125"OD will work

Of course, you can always use raw tubing and build from scratch, instead of using donor bike frames. It would be entirely possible to build 75% of this frame from scratch, but the rear wheel stays are a 26" Mountain bike fork, and the entire Powertrain Assembly is probably best built from existing frames, since the alignment, geometry and welding are already done for you. So these portions of the frame should be from donor bikes.

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To begin construction of the Main Frame Assembly, cut an 19.8" long section of 1.25"OD tubing (the Down Tube on the mountain bike). Make a copy of all sheets in Appendix A. Cut out Figure A, making sure to cut very precisely on the lines. This paper cutout, when wrapped around the 18" long piece of 1.25" OD tubing, will show the miter cut that must be made on one end of this tube. Wrap the cutout around the tube at the very end, leaving just enough tubing to cut this joint. Tape it securely in place, making sure the ends of the miter line up. Trace this miter pattern onto the tube, and then remove the paper cutout. Using a jigsaw, grinder, or hacksaw, remove the excess tubing material. When you are done with this step, you should have a 1.25"OD tube, approx. 18" long, with a miter at one end that will accept the 1.13"OD Head Tube perfectly at the correct angle. If not, get out your file and form the miter so that it fits precisely.

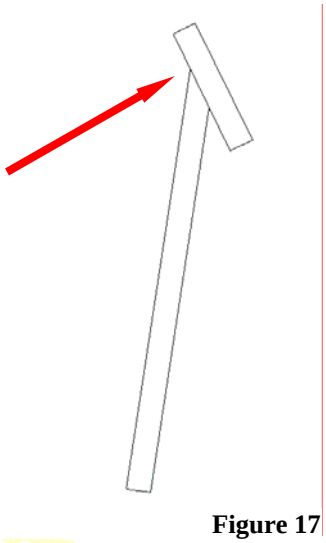

Figure 17

Take the cleaned and prepped Head Tube, which should be approx. 6" long, and lay it on your brazing surface. Mate the Down Tube to it, approximately in the middle, as shown in Figure 17. The resulting angle between the two parts should be approximately 40 degrees. If not, check the miter, and file as appropriate to create the proper angle. It will be acceptable if you lose ½" or so off the Down Tube due to having to correct this joint.

Both tubes essentially self-align themselves, since they are so close in outside diameter. You may have to shim the Head Tube slightly to achieve perfect alignment. Visually check to ensure alignment between the two.

After cleaning all mating surfaces with a solvent and then emory paper to ensure both surfaces are totally clean, apply flux to both parts, clamp and braze. You may clamp the parts together using something as simple as several paver bricks or angle iron holding the alignment of both parts. Whatever you use to clamp the parts, make sure that these items are far enough away from the joint to ensure they will not burn, explode, etc...

After completing this joint, you are ready to move on to the second joint, the Seat Tube to Down Tube joint (fig. 18). Cut a 15-1/2" long piece of 1.125"OD tubing (the old Top Tube from the mountain bike). Copy and cut out Figure B, just as you did with Figure 17. Prep the tube in the same fashion and braze. The angle between the Seat Tube and the Down Tube should be approx. 99 degrees. Position the Seat Tube so that there is room to braze all around the joint. Refer to figure 18.

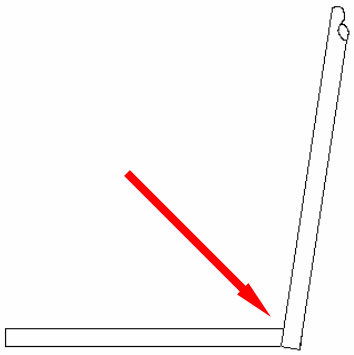

Figure 18

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The next joint is the junction between the Seat Tube and the Chain Stays. There is a major difference between the Chain Stays used on this frame and the donor frames. The donor frame's Chain Stays are typical, small diameter tubing that is triangulated for strength. The atom™ BLASTER™ design uses the front forks from the mountain bike donor for the Chain Stays. This is done for style, strength, passive suspension, ease of construction, and low weight.

To begin, you must first prep the forks. If there are V-brake bosses, you must either un-braze or cut/grind them off (if building 20" version). I prefer to un-braze them, so the bosses can be re-used later. If you are using a cheapo mountain bike, chances are your V-brake bosses are welded on, leaving you no choice. You must cut the bosses off, and grind the remainder off so that the forks show no sign of the brake bosses. Of course, you could always use a set of forks off an old road bike, but the curved style of the newer mountain bike forks look great on this frame (and they're really strong, they flex less laterally).

After grinding off the brake bosses, clean the entire length of the fork stem in preparation for brazing. There is a bearing race at the bottom of the fork stem that must be removed. It is probably a shiny part right above the fork crown. Remove it by flipping the fork upside down in a vice, and using a hammer/punch/screwdriver to drive the race off. A couple quick, hard blows should free it. Sometimes the race will just slide off by itself.

SKIP THIS NEXT STEP AND SEE APPENDIX D FOR TRAVEL VERSION

Now move on to the Seat Tube. Insert the fork stem into the back of the Seat Tube. It does fit, doesn't it? There should be a small amount of clearance between the two, but no more than approx. 1/32" total radially. You want these two parts to mate together fairly well, since they will be brazed together. Measure the length of the fork stem that is not threaded. Take this measurement, and transfer it to the rear end of the Seat Tube. Drill 1/8" holes all around the Seat Tube, approx. 1"-2" apart (see figure 19).

Prep both the inside and outside of the Seat Tube for brazing, and the outside of the fork stem. Insert the Fork stem into the Seat Tube fully after fluxing, and ensure that the Down Tube is perpendicular to the fork legs when viewed from behind. This can be done with a level and a carpenters square. Brace the assembly.

Braze the two together by heating the 1/8" holes and inserting the filler rod into each one. You should be able to watch the brazing rod flow into the hole and fill the gap between the fork and the Seat Tube. This will create a very strong joint.

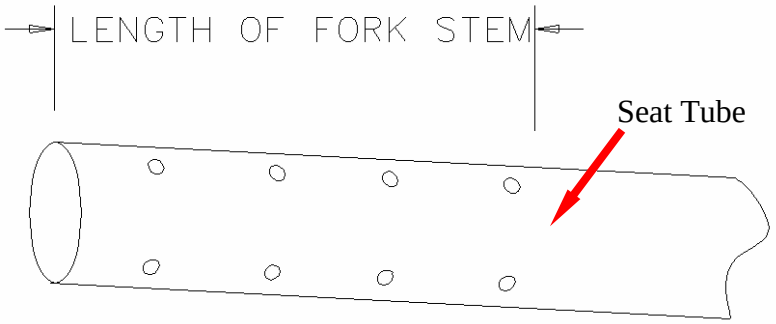

Figure 19

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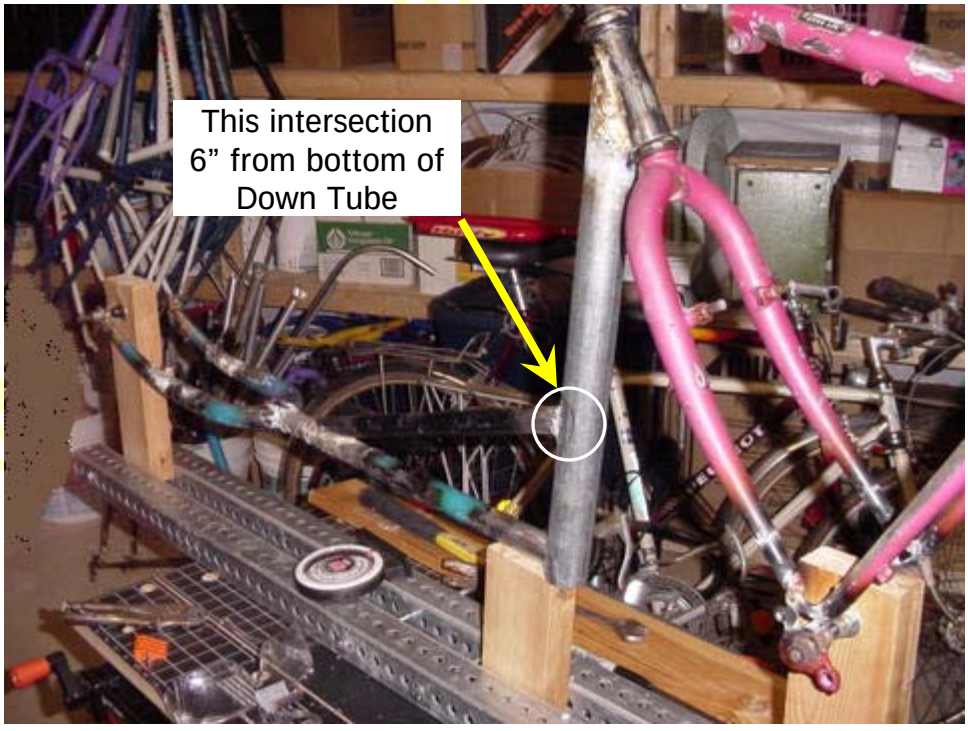
Finally, the Frame Assembly must be triangulated for strength. A diagonal stiffening brace (the Seat Tube Brace) will be added between the Down Tube and the Seat Tube. As you can see in Figure 20, the Seat Tube Brace will be located approximately 6" from the top of the Seat Tube to the top of the intersection with the Down Tube, and the resultant angle is approximately 20 degrees measured off the Seat Tube. The size of the Seat Tube Brace should be either a 1"OD or 1.125"OD tube from a donor bike frame. You should be able to take this tube from the Top Tube of your second donor frame.

The cut length for this tube should be approx. 17.2" long. After cutting to length, prep the ends of the tube for the miter joints. Cut out Figures C and D from the Appendix of these plans, tape, mark and cut each end of the tube per previous joints. Refer to picture on page 23. Once you have prepared both ends of this tube, and the intersection areas of both the Down Tube and the Seat Tube, braze in place, keeping the Seat Tube Brace to Down Tube intersection approximately 6 inches from the Seat Tube, as shown in Figure 20. Later, you will mount your seat bottom to this brace.

Once you have completed brazing the Down Tube Brace, you have completed all the major work on the frame!

Figure 20



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Pictures- Frame without Seat Tube Brace

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Pictures- Frame without Seat Tube Brace (cont.)

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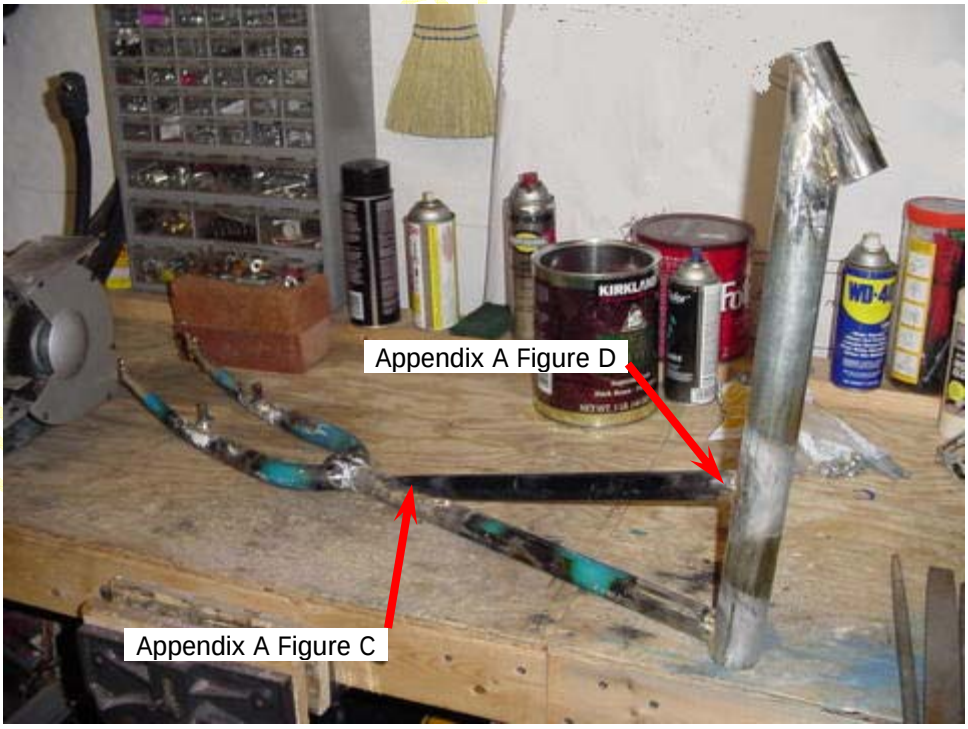
Ovalized Downtube joining Headtube



Finished Main Frame Assembly

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Down Tube joints at Seat Tube and Seat Tube Brace

Painted Main Frame Assembly

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Front Powertrain Subassembly Brace

Introduction

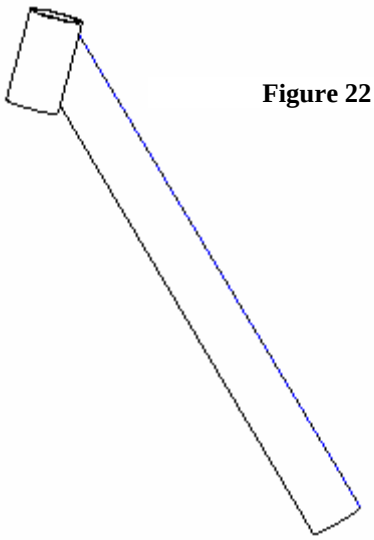

Figure 22

As can be seen in the pictures above (pg 22), there is one piece missing from the front triangle. This is preventing the Front Powertrain Assembly from being very strong. Refer to the picture just above. Notice that at the top of the old "seat tube" there is a seat post clamp integrated into the tube. This will be used to clamp the new Front Powertrain Subassembly Brace into place. But first you must fabricate this brace. Refer to top picture pg. 48.

Brace Fabrication

Begin by cutting a 2" section of 1.125" tubing. It is important that you can sleeve this tubing over the handlebar stem that you will use for this bike, so get that part for future use. Cut a 15" long piece of 1" tubing. Make sure this tube will slide into the old seatpost clamp. Grind a 45 degree miter into the 15" long piece of tube. Insert the handlebar stem thru the 2" long tube, and then into the threaded fork stem. Mate the 2" long piece into the miter. Check the gap in the joint, and adjust if necessary. If everything is acceptable, pull everything apart and braze the 2" long tube to the 15" long tube, as shown in Figure 22.

Next, you will have to braze a clamp onto the 2" long tube. Take a 1" long, ¼" coupler nut, clean it and braze onto the 2" long tube opposite the side which the 15" long tube is brazed. Once the braze is complete, cut a slot from the top of the 2" tube to the bottom, vertically thru the middle of the coupler nut. Place the entire assembly in a drill press, and using a bit slightly larger than the root of the threads in the coupler nut, drill out one half of the threads. Thread a 1.5" long ¼" socket head cap screw into the clamp from the side with no threads. This clamp should now be re-assembled per above directions to test if the clamp will secure the front triangle. You may cut some length off this part if necessary. See Figure 23.

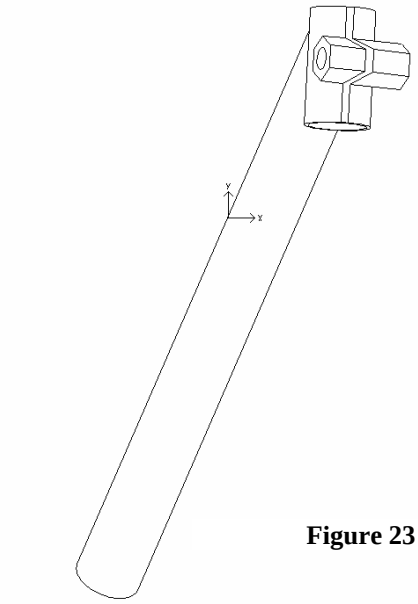

Figure 23

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Brake Mounts

Introduction

The atom™ BLASTER™ uses brakes that were salvaged from the mountain bike used as a basis for this project. Typically, the best brakes to use on this bike are V-brakes. This is due to their low (or no) cost, the ability to recycle the canti bosses used to mount the brakes, ease of cabling, and their extremely high braking strength.

Installing the Brake Bosses

To begin, mount both front and rear wheels to the bike frame. Start with the front wheel. Take a V-brake with pad loosely mounted, and screw it to a canti boss. Place the pad onto the wheel rim in the general area that it would need to contact the rim, approx centered in the adjusting slot of the V-brake. Holding the pad in that position, maneuver the canti boss mount so that it fits against the frame, where it will be mounted. Mark the centerline of the stud mount on the frame, in an area away from the actual weld area so that when the studs are positioned for welding/brazing, the mark will be visible. Transfer this mark to the opposite side of the frame, so that both canti boss locations are marked. Repeat the above steps for the rear wheel. NOTE: If you used a MTN bike type front fork in the Powertrain Assy, you may have to use a canti or road brake in front. This is due to the excess distance created by spreading the front fork.

You will need to make a simple jig to hold the canti boss in place during brazing. Do a Google search for “canti brake boss jig” to find many illustrations and instructions on how to build one. Use the jig to hold the bosses in place and braze. A sample image of a typical spring-style canti boss jig is shown for reference. This jig can be easily made from scrap iron, such as a bed frame. The narrow strip down the middle of the jig puts the bosses under tension and holds them in place against the frame for brazing. This jig is fully adjustable.

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PART TWO- BUILDING THE SEAT

Introduction

In this section, we will continue the build process by creating a seat for the atom™ BLASTER. There are many different seats which may be used on this frame; one will be detailed in these plans. The seat is a padded base/tubular back seat similar in construction to many seats found on production recumbents. This section will provide detailed construction processes for this seat.

Fabrication- Seat Base

This seat base is created from a piece of 3/8" or ½" plywood. To begin, lay the plywood on a flat work surface. With a pencil, draw all the dashed lines shown in Figure 24 on the plywood. This will define the perimeter dimensions for the seat base. After doing so, draw the two solid lines shown in Figure 25.

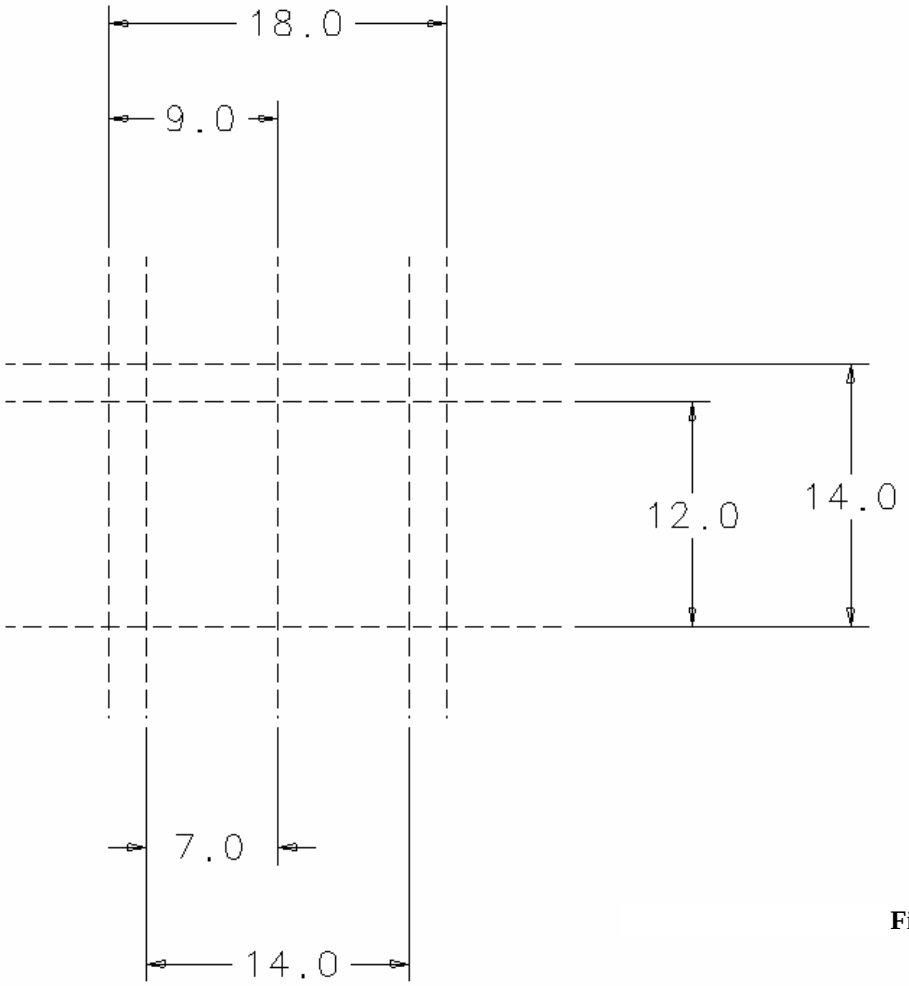

Figure 24

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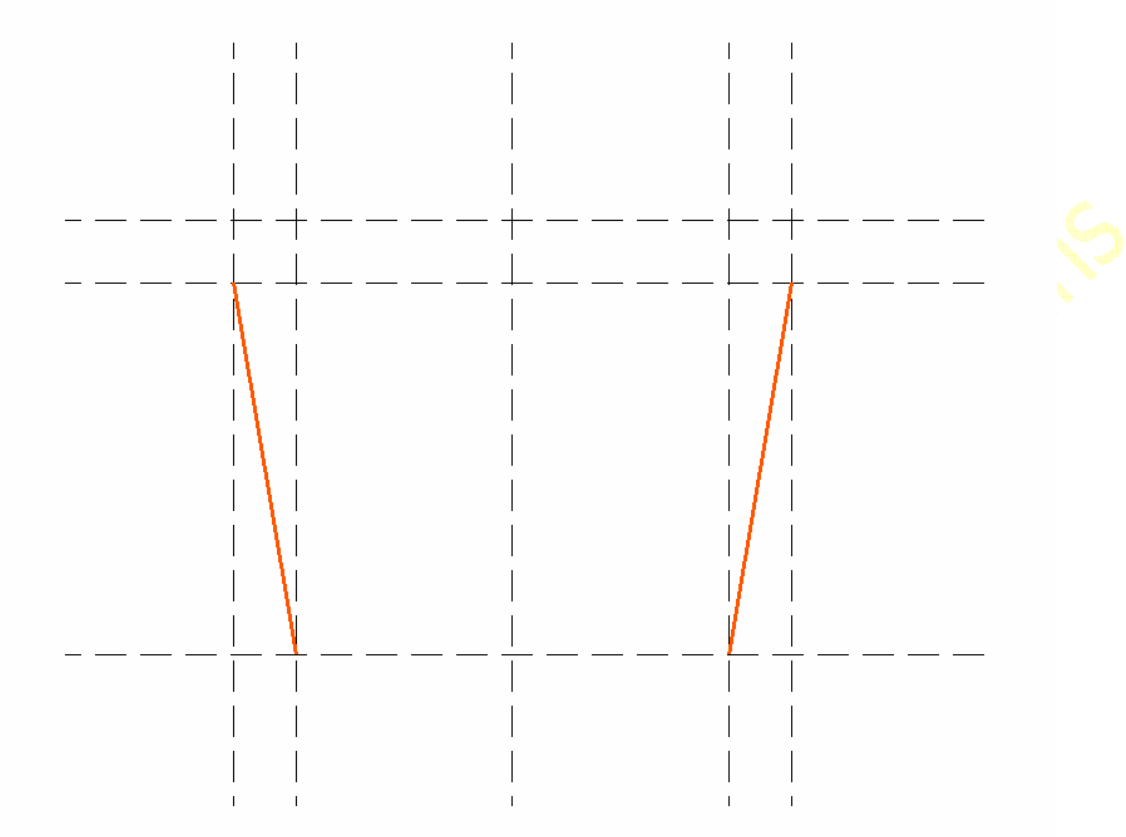

Figure 25

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Next draw a circle with a diameter of 4” as shown in figure 26.

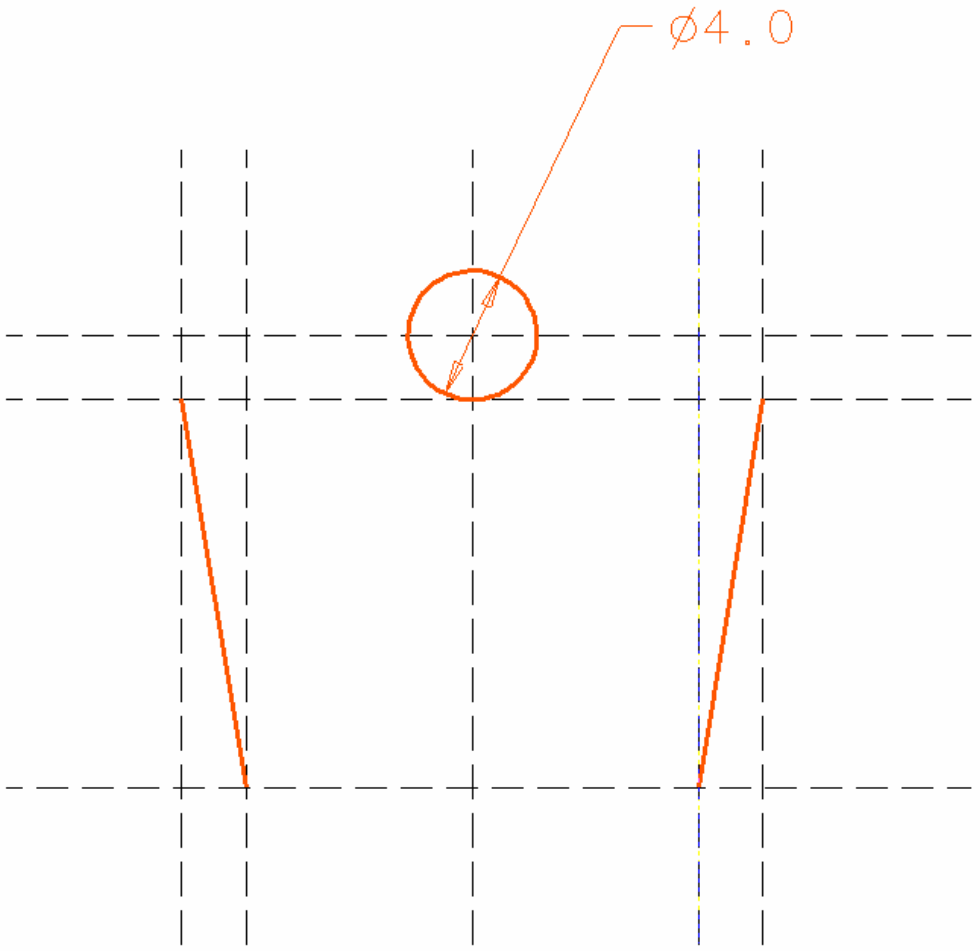

Figure 26

Finally, complete the layout by rounding all the corners with a 3” radius fillet, as shown in Figure 27. Of course, the dimensions used for this seat base are typical, and you may change dimension values to suit your needs. You may even remove the entire “horn” at the front of the seat, if you need to get your seat closer to the Downtube. Do NOT erase any of these lines after you are done cutting this part out, as you will need the construction lines to place the mounting holes. After laying out all the lines and fillets, cut out figure with a jigsaw.

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Next, refer to Figure 28. Mark and drill four ¼" clearance holes using the dimensions shown. Insert four ¼" tee nuts into these holes from the topside of the seat base. You will need to hammer these into place.

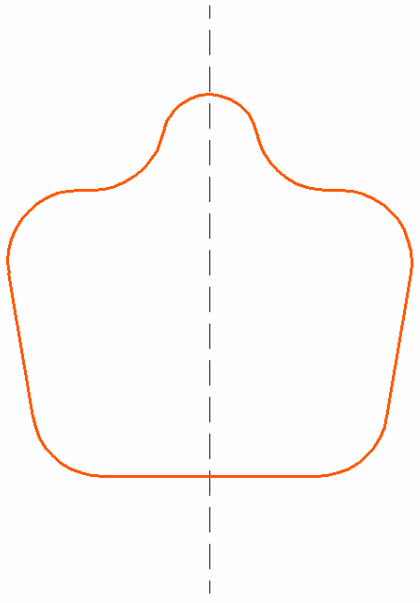

Figure 27

Source 2 "T" hinges for the seat. These hinges will be the pivot between the seat base and back, so they must be strong. The hinges should be either plated or galvanized to resist corrosion. The hinges should be approx. 2-1/2" long, and each leaf should be no wider than ¾". McMaster Carr PN 1530A32 is a good choice. Transfer the hole locations of the holes in the strap portion of the hinge to the rear edge of the seat. Drill ¼" holes and put tee nuts in these 4 holes from the topside.

Cut a piece of dense foam to 17" x 17" size. A laminate of camping mat works well. Camping mat foam will not absorb water, it is closed cell foam. This is the type of foam to use. Glue the foam to the top of the seat base using spray adhesive, such as headliner glue. Apply even weight to the foam to ensure good contact with the plywood, and let sit overnight to dry. Once dried, cut the foam using a long serrated knife. Use the plywood as a guide to trace the outline of the seat base with the knife. At this time you should sand and polyurethane or paint the bottom to protect it from the elements. Also, the foam can be shaped with rough sandpaper, if desired.

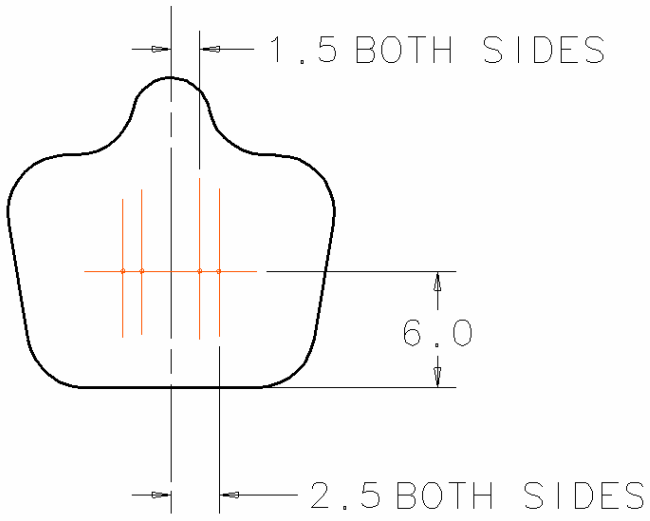

Figure 28

To cover the seat base, take a piece of durable black lycra and stretch equally from all sides; stapling the fabric to the plywood base as you go. Or, you can make a removable cover by sewing elastic into the edge of the lycra cover.

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Fabrication- Seat Bracket

You will need to make a bracket to mount the seat onto the bike frame. This section covers fabricating that bracket. Refer to Figure 29. Take a 1-1/8" OD tube and cut it 6" long. Now split the tube down the middle so that it looks like Figure 29. Clean all edges free from burrs. Place this half-tube on the Seat Tube Brace to ensure it slides over it. Set aside, or spread if it does not easily slide over the Seat Tube Brace.

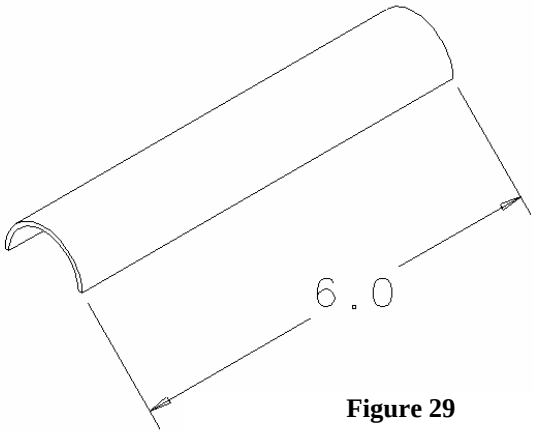

Figure 29

Now refer to Figure 30. This is the part that you will eventually crew the Seat Base onto. This part may be made from a 1-1/2" X 1" angle iron. Hint: a light-duty bedding mattress frame is a decent scrap material to make this from, so long as it is not TOO thick. Since Figures 29 and 30 will be brazed together, they must be made from steel. You may choose to drill additional lightening holes in Figure 30, this should be OK if you do not compromise the strength. The four holes shown in Figure 30 should be centered along the centerline of this new part in both axes. The dimensions for locating these holes should match the holes on the Seat Base. Finally, the large half circle should be along the center of the part, and should be sized to neatly accept Figure 29.

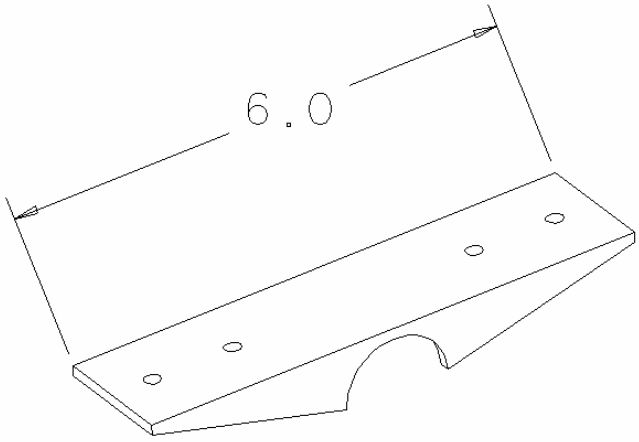

Figure 30

Once you are done cleaning both parts, place Figure 29 onto a flat work surface. Clamp or otherwise hold Figure 30 on top of Figure 29, at a perpendicular angle, looking both from the top and the front. The two parts should be positioned as shown in Figure 31. Prep the joint formed between the two, and braze all the way around.

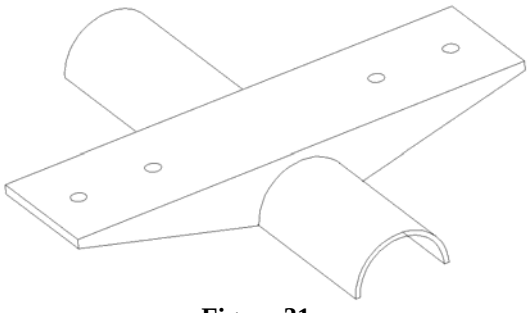

Figure 31

The Seat Bracket is complete. Later, you will screw this to the Seat Base bottom, and fasten to the Seat Tube Brace with hose clamps.

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Fabrication- Seat Back

The Seat Back is made from ¾" emt conduit tubing. The reason for this is that it is cheap, relatively lightweight, and easily formable using standard tools. The best way to place bends in this piece is to use a ¾" conduit bender, sometimes referred to as a "hickey". This tool may be purchased at most hardware stores. If you like, you may substitute ½" conduit in place of the ¾" conduit used here, but the resultant part will not be as strong.

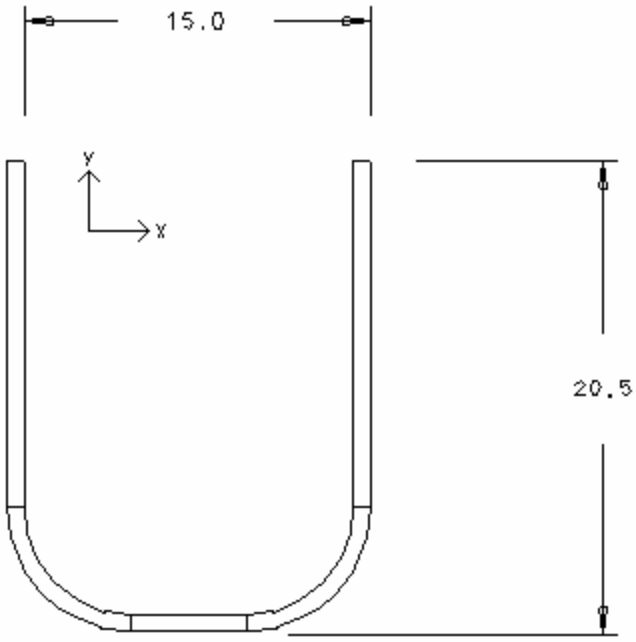

Figure 32

The simplest form for the Seat Back is a simple "U" shape. Simply bend the conduit using the dimensions shown in Figure 32. You may chose to modify these dimensions to suit your needs, but the dimensions shown work well. Also, you may also choose to modify the profile of the Seat Back part so that it has a contour for your lumbar region. To do this, use the same technique used for bending the conduit to make these bends as well. The bent up Seat Back part is shown in Figure 32.

Next, you must create a brace that will stiffen the top tubes of the Seat Back. Refer to figure 33. This brace is 15" wide (or however wide you decided to make your seat back), and is approx. 3" deep. Using the conduit bender, bend this part. Miter the ends of this part to mate with a ¾" emt tube. Position this brace approx. 6" from the top of the Seat Back. Clean the joint areas on both parts, and braze both ends of the brace to the Seat Back.

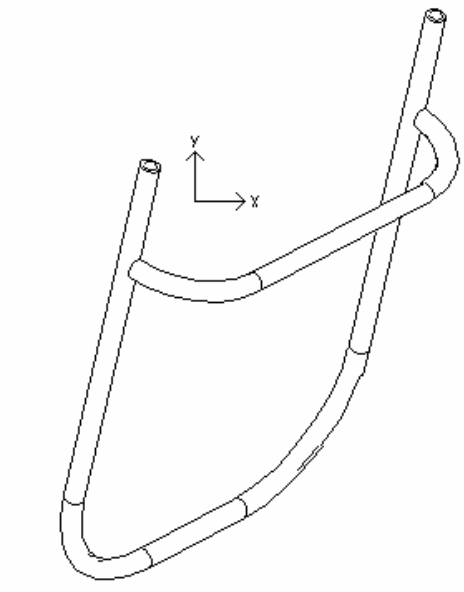

Figure 33

Create a Seat Tab part out of scrap steel, approx. 1" X 1" X 1/8" THK (see Figure 34). On one end, miter to accept a piece of ¾" emt. On the other, center and drill a 1/8" OD hole. Duplicate this part for the other side of the seat brace. Alternately, you can recycle the dropouts you removed from the front fork in Step One of the Powertrain assembly.

Once you have fabricated two of these parts, prep them for brazing. Center them on the Seat Back

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brace, spaced approximately 6”-10” apart. Once you have prepped all joints, clamp these two parts perpendicular to the Seat Back brace, and braze.

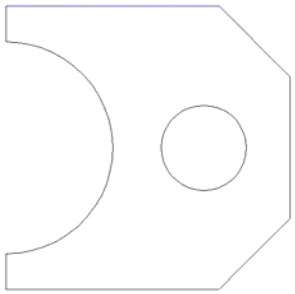

Figure 34

Finally, refer to the two hinges you should now have screwed to the Seat Base. Measure and record the spacing between the two innermost and the two outermost mounting holes. Transfer these dimensions to the middle of the Seat Back bottom. Once you are sure the marks are centered on the bottom portion of the Seat Back, drill qty (4)- ¼” clearance holes thru the Seat Back. These are the mounting holes to attach the Seat Back to the Seat Base. If you have to, you can make these holes slotted to accommodate a small amount of error, or drill multiple holes.

Fabrication- Seat Struts

The Seat Struts are simple. They consist of a 12” long section of 3/8” OD aluminum tubing sleeved inside of a ½” OD X .058” THK (ID is .384”) piece of steel tubing, cut to 12” long. To clamp the outer steel tube to the inner aluminum tube, you will cut a 1” long slit in one end of a steel tube. After cleaning the slit free of burrs, insert the aluminum tube into the steel tube, and clamp using a small stainless steel hose clamp. Flatten both ends of this assembly with a vise or hammer. Drill 1/8” holes in both ends of both assemblies. The completed assembly should look like Figure 35.

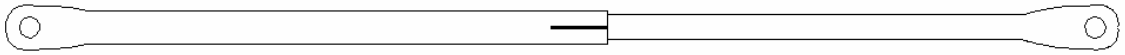

Figure 35

Fabrication- Seat Back Fabric

The Seat Back Fabric is made of a breathable, non-stretchable, durable material known as Phifertex. This type of material is commonly found in outdoor patio furniture cushions. The cheapest local source I have found for this material is a pet screen door material called Pet-D-Fence. It is available at most large hardware stores, and is available in Black (which is typically what is used for this seat back).

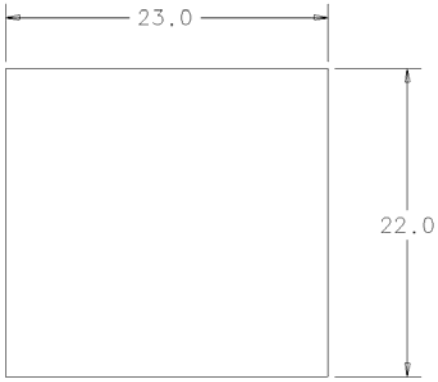

Figure 36

To begin, rollout the fabric on a large flat surface. Mark a rectangular area 23” wide X 22” tall square, and cut this out using sharp scissors or a razor (Figure 36). Fold over the top and bottom edge one inch, and then double that over one inch. Sew

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these two edges down. You should now have a rectangle that is 23" wide but 18" tall. Make sure you sew both top and bottom in two rows, as shown in Figure 37. The dashed lines represent stitching.

Figure 37

Next, fold over both sides one inch, and then again as you did in the previous step. Double row sew this as well. You should end up with a rectangular piece of fabric that is 19" wide X 18" tall, per Figure 38. Fit this over the back of your Seat Back Frame to ensure that it will fit. The fabric will be doubled over the uprights and fastened across the back with zip ties.

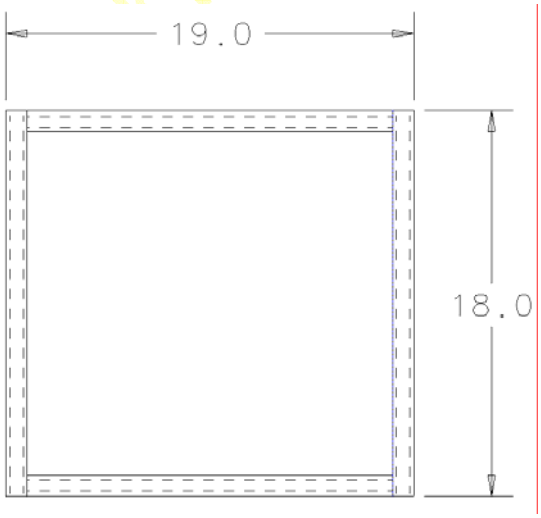

Figure 38

The next step is critical to the success of your Seat Back Fabric. The Fabric must have holes in the edges for the zip ties, and these holes must be supported to prevent rip out due to stresses in the fabric. To support the holes, we will place grommets in each hole, but in addition, a support wire will be slide down into the edge of each side to spread the load on the grommets.

Place a ¼" grommet at 1" from the top of each top corner, centered evenly in the folded and sewn panel, as shown in 39, then continue adding grommets with a 2" spacing all the way to the bottom of both panels. If you measured accurately, there should be a 1" gap between the center of the last grommet and the bottom edge of the fabric on either side.

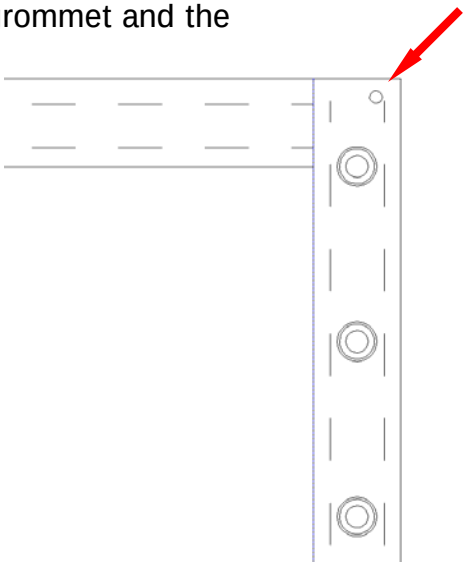

Figure 39

The best way to make the holes for the grommets is to burn them using a soldering iron. Place a round tip on the iron, and once it is hot, you should be able to burn ¼" size holes easily and quickly. Be careful not to make the holes too large! Burn one hole and test fit a grommet thru it. Alternatively, you can make the holes by heating an old metal coat hanger with a torch. Try to set the grommet in each hole while the fabric is still hot and pliable. The melted ring of nylon will conform to the inner contour of the grommet shoulders and lock every strand of thread in place.

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Finally, burn a 1/8" hole thru the outer fabric (see arrow-Figure 39) into the "core" of the folded edge, on both sides. You will later run a support wire down this hole to support the grommets.

Final Assembly- Seat

Once you have reached this point, you have fabricated all the parts necessary for a completed atom™ BLASTER™ seat. Screw the Seat Bracket to the Seat Base; Insert (4) 1.25" long ¼" screws thru the (4) holes in the Seat Back, and the fasten to the hinges on the Seat Base using ¼" washers and nuts; and then fasten the steel tube portion of the Seat Struts to the Seat Tabs using ¼" fasteners.

Figure 40

Cut two pieces of 12 or 14 gage insulated copper wire (or other similar non-rusting firm material) to a length of 17.5" each. Do not strip the insulation off. These wires will be used as a support for the Seat Back Fabric, to protect the grommets from pulling out due to the high stresses that will be placed on the Fabric. Bend a "hook" at the top of each wire as shown in Figure 40.

Take the Seat Back Fabric, and slide the wire into the 1/8" holes that were burned into the tops of the Fabric. Slide the wires down each side, so that the wires are snug between the grommets and the adjacent stitching (figure 41-wire shown in blue). Insert fully.

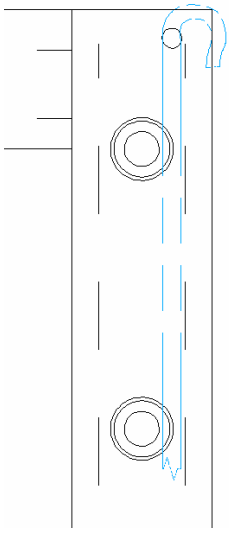

Figure 41

Fold both Seat Back Fabric edges around the Seat Back Frame, and secure thru the grommets with large industrial strength zip ties. The wires will support the grommets and help spread the stresses, as shown in Figure 42.

Set aside the completed Seat Assembly or you can trial fit the Seat on the Seat Tube Brace at this time using hose clamps. The Seat Struts screw to the eyelets that should have been left on the fork used for the rear wheel stays, and the Seat Bracket fastens to the Seat Tube Brace using four hose clamps.

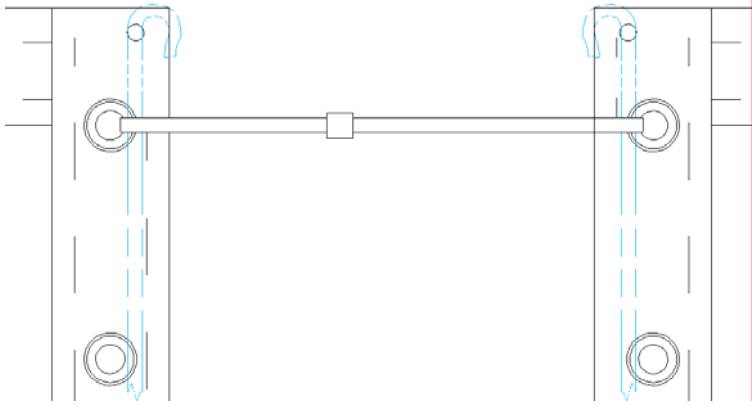

Figure 42

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PART THREE- HANDLEBARS

Introduction

In this section, we will continue the build process by creating a set of handlebars for the atom™ BLASTER. The bars used on this bike are constructed of either ¾" emt (for low cost) or similar sized aluminum tubing. (note: you may elect to use "cruiser" style bars shown in the finished pictures on the red bike; this works very well)

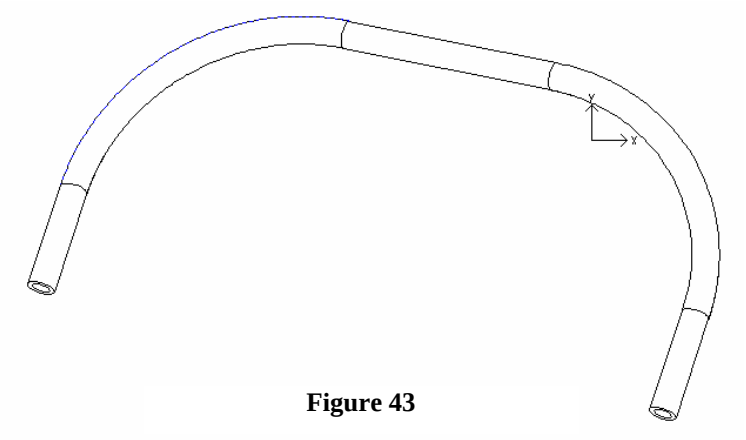

Figure 43

Bending the Handlebars

Whether you use either choice of material discussed above, you can use the ¾" conduit bender to shape this part. The bars are bent in a "U" shape, wide enough to allow easy leg clearance even when turning sharply. The bars allow your arms to hang to the sides while riding, and provide a decent size moment arm to counteract the input forces caused by your legs while riding. In other words, you will use these bars to overcome the zig-zag motion caused by your legs while pedaling.

Use the dimensions shown in Figure 44 to bend the bars. Cut a piece of ¾" tubing approx. 36" long. Mark the middle of the tube. Place the tubing bender so that it will bend a 90 degree bend starting around 3" from the middle mark you just created. Bend the tube 90 degrees. Repeat for other side. Ensure that both ends of the tubing are laying in the same plane (by laying them on a flat surface); if not, you will have to bend the bars so they will lay flat. You may alter the dimensions shown to your preference. At this point, the bars are done.

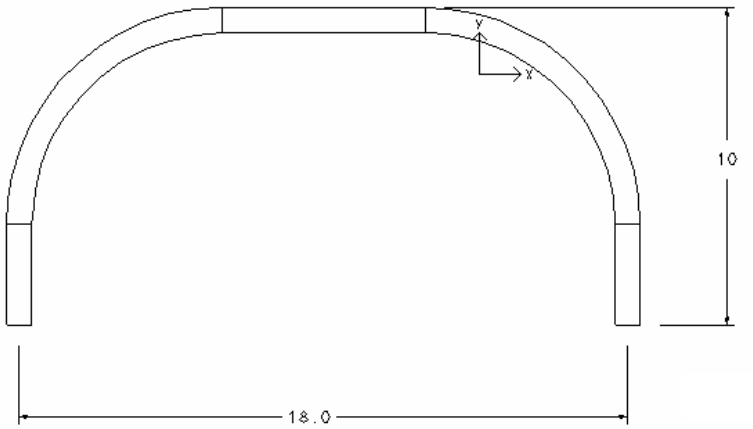

Figure 44

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PART FOUR-FINAL ASSEMBLY

Discussion

You should now be realizing one of the greatest benefits to building the atom™ BLASTER, and that is that you are almost done! The simple design of this bike allows for very short fabrication/build time, to get you on the road fast.

Assembly

Begin the assembly process with the Front Powertrain assembly. Slide the Front Powertrain Assembly Brace (Figure 23) into the clamp at the top of the Powertrain assembly. Secure temporarily with a seatpost bolt or quick release. Place the race/bearings/etc on the bottom end of the fork stem. Slide the threaded fork stem up thru the Head Tube. Secure the fork with bearings/nuts/etc. Release the clamp holding the Front Powertrain Brace, and align the Brace with the Head Tube. Now Slide the Handlebar Stem down THRU the Powertrain Brace and into the fork stem. Tighten first the wedge in the Handlebar Stem, then the clamp on the Powertrain Brace. At this point, the front triangle is assembled and should be rigid.

Next, install the wheels front and back. Loosely install the V-brakes front and rear. Install the chain from the donor bike.

At this point the seat may be installed. Place the assembled Seat onto the Seat Brace Tube. The Seat Bracket should slide onto the Seat Brace Tube. Secure the Bracket temporarily with hose clamps. Swing the Seat Struts back to the eyelets on the rear fork and attach. You may have to loosen the clamps on the Struts to expand/contract them to align properly with the eyelets. Tighten the Seat Bracket hose clamps.

The last major assembly step is attaching the handlebars, but this is a minor thing. Simply slide the handlebars thru the handlebar stem clamp, align per the pictures, and secure the clamp.

Add the derailleurs at this stage. Mounting of both the front and rear derailleurs is identical to the bike that the parts came from.

At this point you may install shifters, brake levers, and cables. Shifters, cables and levers may be used directly off your donor bikes. Congratulations! The assembly of your atom™ BLASTER is complete.

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PART FIVE-RIDING THE atom™ BLASTER

Discussion

This bike was designed to be stable at both low and high speeds. Because the center of gravity of the bike is so low to the ground, do not be surprised if you do not immediately "get on and go" like you would on your old Schwinn. The reason for this is simple, and can be illustrated. Take a broom handle or other long cylinder and balance it on the open palm of your hand. It's relatively easy to do, right? Now take a pencil and try to do the same thing. Not so easy, is it? The reason the broom handle is so easy to balance is because of its length.

Balance is defined as "A state of equilibrium or parity characterized by cancellation of all forces by equal opposing forces". It is nothing more than moving an object in a certain direction to compensate for a shift in the center of gravity of that object. So with the long broom handle, there is a longer reaction time allowed for you to stabilize the forces. The short pencil allows a very small time to correct, and you end up over-correcting in one direction, which shifts the CG (center of gravity), and then you overcorrect in the opposite direction…you get the picture.

The same thing occurs with bicycles. With a "regular" diamond frame style bike, the rider is sitting quite high (like a broom stick). The distance from the pivot point (the tire contact patch) to the CG is large. Balancing is easy. With a low racer, the distance from the pivot point to the CG is quite small, since the bike is so low. It's not quite like balancing a pencil on your palm, but there is a steeper learning curve for this style of bike. In addition, with a regular bike, you contribute to the balancing effort by shifting your body mass from side to side by leaning. This is not so easy on a recumbent bike, because your torso is basically pinned to the seat back.

As if things weren't complicated enough with the low CG, let's introduce something called "pedal steer". With a "normal" bike, the Bottom Bracket is firmly fixed to the frame. Thus, any forces put into the crank go into driving the chain, and there are some losses to the frame. With the atom™ BLASTER, the Bottom Bracket pivots about the Head Tube. This is both good and bad.

Let's cover the bad first. Pedal steer causes large forces to the pedals to cause the bike to want to steer in the opposite direction i.e. you push with your left leg, the bike slightly steers to the right. Obviously, this must be overcome in order to ride the bike in a straight line.

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Now the good news. It is easy to overcome pedal steer, here's how. On any recumbent bike, the "spinning" technique of pedaling is used rather than the "mashing" technique. The difference is cadence. Spinning is a balanced, rhythmic pedaling technique that typically requires higher revolutions per minute than mashing. It also generally involves pedaling in a "square" pattern, which usually means using clipless pedals. Clipless pedals are good on any recumbent because they keep your feet from slipping off the pedals.

The good news is that spinning is considered a healthier way to pedal any bike, it is easier on the knee joints, and it gets your heart rate up. Healthy spinning lessens pedal steer in two ways; the forces are not as dramatic as they are with mashing, and when spinning, you push with one foot while pulling with the other. So the forces about the Head Tube are almost self canceling. The rest of the pedal steer forces can be counteracted thru the handlebars. The atom™ BLASTER handlebars are designed to be the size and shape that they are, to act as a large lever arm to counteract pedal steer (and they put your arms in a relaxed position). Once you have mastered riding the bike, you can play around with smaller handlebars.

Armed with this knowledge, you should be prepared to take your first ride. First, check to make sure that the entire bike including derailleur cables and brakes are properly installed, adjusted and tightened correctly. Wear a helmet, and gloves might be useful for your test rides. Use platform pedals on this bike until you are totally comfortable riding it; do not use clipless pedals for your test rides.

When starting out, it is best to make your first attempts facing down a slight grade, in an open area with no traffic (foot or otherwise). Set the derailleurs to place the bike in the absolute lowest gear available. Everything else is pretty much like riding any other bike. When you first start riding, you will probably notice the pedal steer effect. Don't worry about this; it will go away as you gain seat time on the bike. You will probably notice that you can use the handlebars to counteract the pedal steer. This is a helpful technique that you should use until you develop your spinning technique.

Do not attempt to go fast until you have really adapted your riding technique to this bike. It is important to have your brakes properly adjusted. If you notice that the bike begins to zig-zag while increasing your speed, you may need to remove your feet from the pedals and hold them in the air to the sides of the pedals. This should cause the bike to come back into a straight line.

IMPORTANT: Do not ride the bike unless you are confident you have followed the plans and have built the bike frame using good building techniques.

Get out there and log some seat time on the atom™ BLASTER !!!!!

atombikes@gmail.com Edgar K. Atkins

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APPENDIX A- Miter Joint Cutouts

Note: There is a free program credited to Giles Puckett called "tubemiter.exe" which was used to create these miters. If these images do not scale/print correctly, download a copy of this program and re-run them using the parameters shown.

Figure A- Down Tube to Head Tube Miter joint

1.25" tube meets 1.13" tube- refer to Figure 17

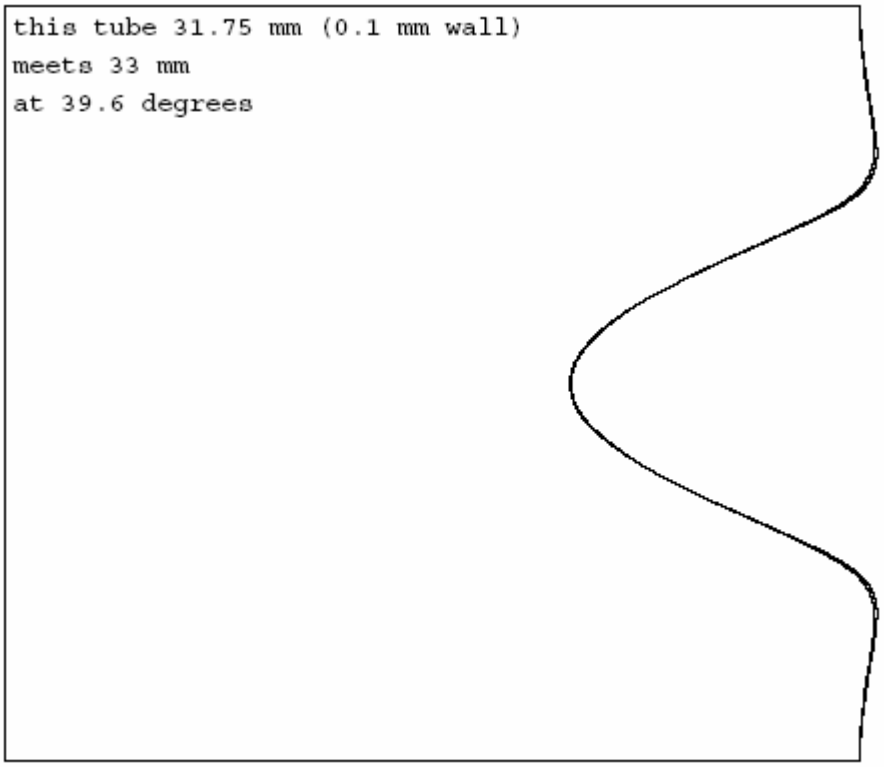

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Figure B- Seat Tube to Down Tube Miter joint

1.125” tube meets 1.25” tube – refer to Figure 18

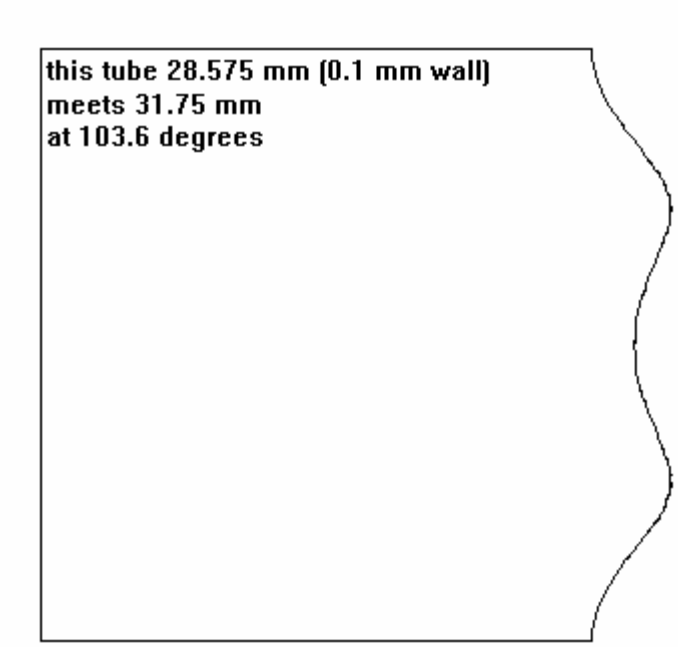

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Figure C- Seat Tube Brace to Seat Tube Miter joint

1” tube meets 1.125” tube at 20 degree included angle. Refer to Figure 16

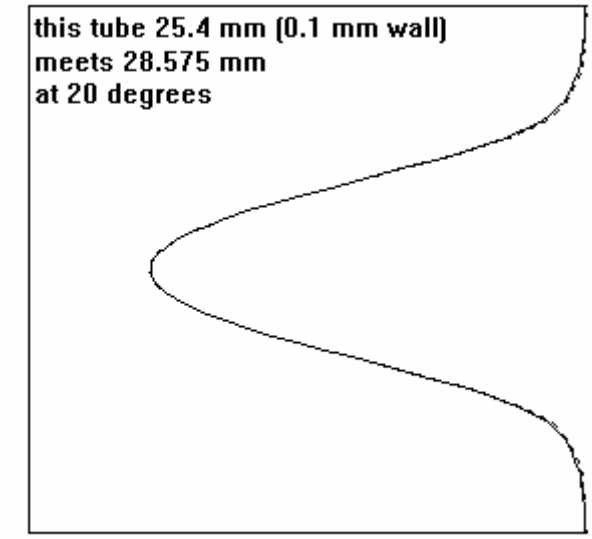
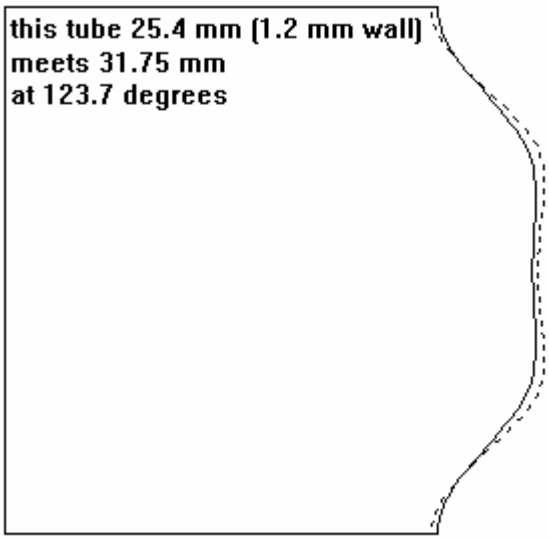


Figure D- Seat Tube Brace to Down Tube Miter joint

1” tube meets 1.25” tube at 119 degree included angle. Refer to Figure 16



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APPENDIX B- Finished Bike Pictures

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APPENDIX C Framebuilding Jig

A jig is not required to build this frame; however, it is a “really good idea™”.

The jig that I use is nothing more than two 5ft lengths of 2”x2” square section steel. As you can see in the pics, the tubing has 3/8” holes punched in it on all sides, approx. spaced 1” apart. This enables the jig to be configured in many ways. Sandwich the 2”x4” supports for the dropouts between the two jig main rails. Ensure the holes thru the 2”x4”s are drilled square to the face.

Of course, a really inexpensive and effective jig is to use two pieces of 4” X 4” wood, laid side by side and drilled in several locations. If you use this method, make sure the wood is not warped (obviously).

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APPENDIX D Travel Version

As I designed this bike it became apparent that due to its small size and compact drivetrain, that it would be totally possible to build a version that could be broken down for travel use. This section details the change required (yes only one change!).

Since all cables but the rear brake are contained in the front of the bike, and since the rear brake utilizes a quick release feature, it is totally plausible to remove the front section of the bike with cables attached, and disconnect the rear brake at the quick release to have a pretty compact package.

But the rear stays (fork) still protrudes, and prevents packing the frame in the smallest possible package. The solution to this problem is to utilize 2 or more pinch bolts to hold the rear stays (fork) on the frame, in the area depicted by the red arrow in the photo below, ***in lieu of the series of brazed holes as depicted on page 19 of these plans.*** The pinch bolts should be created using ¼" (or 3/8") hex coupler nuts, in the same manner as was used for the pinch bolt for the Front Powertrain Subassembly Brace (figure 23). The slot should face the bottom of the frame, i.e the couplers should be brazed to the bottom of the frame where the rear stays fork slides in. The slot should be cut sufficiently wide to allow the main frame tube to securely clamp the steerer tube portion of the rear stays fork.

This modification to the base plans for this bike not only allows greater portability (take your bike with you on vacations!) but it also allows greater flexibility in making adjustments to the front/rear wheel alignment without cold setting the frame.

This bike is not considered a "folder", but is very compact when broken down. The breakdown sequence is 1) loosen Front Powertrain Subassy Brace bolt; 2) loosen handlebar stem and remove (cables attached); 3) remove headset nut at top of fork and remove Front Powertrain Assembly; 4) disconnect rear brake cable; 5) loosen Rear Stays Clamp bolts and slide out rear stays fork. DONE!

After completing the above modification for the travel version, go back to the top of page 20 and proceed.

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